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industry from a manufacturing point of view. After this I occupied myself with scientific research, some of which was connected with coal-tar coloring matter, but mostly with other subjects. Some of these are still occupying my attention. But I must not enter into details, as time would fail me.

One of the most remarkable developments of the industry has been the artificial production of indigo, and, curiously, the first process for its manufacture, discovered by Professor v. Baeyer, was dependent for its success on the method of producing cinnamic acid, discovered in my purely scientific investigations, and this dye is now manufactured so cheaply that the cultivation of the indigo plant has been discontinued in many parts of India.

As I mentioned, when I started this industry I was determined not to give up scientific research, and so long as I had to do with it the part I took in its development resulted from the union of industry and scientific research. This has been followed up by others, especially in Germany, and owing to the work of an army of chemists, many of them men of great eminence and most of them engaged in the works and their laboratories, this wonderful development, unequaled in the history of industry, has taken place. This industry has also had a marvelous influence on the development of science itself. Its wonderful growth has also, as a matter of course, created not only directly but indirectly an immense amount of employment for men of all classes, especially the working classes, which can not be gauged, and although America has not become a manufacturing center for the production of these dyes, no doubt many thousands of American workers are engaged in the applications. That this industry which I was permitted to found should have led to this result is a source of pleasure to me, because the final result of our work should be the benefit of mankind.

You have been so good as to honor me by having this jubilee in remembrance of the part I have taken in connection with this coal tar color industry, and whilst I am thankful that I had to do with its foundation and early development, yet I feel that the part I have taken is indeed small when compared with the labors of the army of scientific men and others, both inside and outside the color works, who have advanced it to its present condition. At the same time it is very gratifying to me to receive all the generous and kindly expression of feeling you are manifesting, and I thank you very heartily. But what have I that I have not received? It is not, therefore, for me to boast (and I also feel that I have but imperfectly used my opportunities). I, therefore, can only say in reference to the success which has attended my efforts, Not unto me, O Lord, not unto me, but unto thy great name be all the praise.

REFORM IN MATHEMATICAL INSTRUCTION.

THE principal mathematical reforms recommended by the commission appointed by the Gesellschaft Deutscher Naturforscher und Aerzte is that more emphasis should be laid on the development of the concepts of *function* and *space*.[1] As the commission realized that such fundamental changes are not likely to be accomplished by a mere publication of the results of its deliberations, it appointed two of its members—Professor Klein, of Göttingen, and Professor Chun, of Leipzig—to try to interest secondary teachers in the subject, and, if possible, to bring them to discuss it very freely.

[1] 'Bericht der Unterrichtskommission der Gesellschaft Deutscher Naturforscher und Arzte über ihre bisherige Tätigkeit,' Leipzig, F. C. Vogel, 1905.

The chief aim in this reform is to bring the mathematical instruction in closer touch with applications. Related variables present themselves very frequently in the sciences, and the training in algebra should prepare the student to deal with these concepts in an intelligent manner. More stress should be laid on the study of expressions and less on the analytic transformations and the solution of equations. Graphic representations are especially helpful in the study of the various values of algebraic expressions, and hence these should occupy a more prominent place in algebra. Fortunately, these changes are being effected not only in Germany and France, but, perhaps, in a more rapid manner in England and in America.

The instruction in elementary geometry is at present undergoing the most radical changes, especially in England, which was the last great stronghold of Euclid. The fact that Euclid's 'Elements' remained a standard elementary text-book on geometry for two thousand years reflects less credit on Euclid than disgrace on those who followed him slavishly. During the last few years England has abolished Euclid servitude and her freedom is clearly exhibited in the recent text-books. The 'Manual of Geometry,' by the well-known author, W. D. Eggar, is, perhaps, a somewhat extreme case. In this book there is a chapter describing the vernier, spherometer, callipers and the micrometer screw gauge. It also treats briefly of the mensuration of the simpler geometrical solids, trigonometric ratios, and four-place logarithms.

In France the 'Nouveaux éléments de géométrie' by C. Meray has, perhaps, been the most effective in producing a decided advance. In this work the plane and the solid geometry are not separated, the concepts parallelism and perpendicularity are established by means of translations and rotations, and the theorems relating to the congruence of triangles are developed later than is customary in the classical works. At a recent meeting of the French Association for the Advancement of Science a resolution was passed requesting the minister of public instruction to assist in securing a more general adoption of these methods in the text-books.

While we may not be able to foretell what the elementary geometry of the next decade will be, yet it seems probable that philosophy will largely give way to observation, the abstract to the concrete, the rigor which appeals to the scholar to the elementary methods leading to a clearer understanding of our physical surroundings. In view of the fact that England was the last one of the great nations to abandon Euclid, it seems likely that she will soon produce the best text-books in elementary geometry, for she is in a position to profit by the experience of the nations which made the transition at an earlier period.

There are two subjects whose elements should constitute a part of a regular course in elementary geometry, viz., analytic geometry and vector analysis. These open up such wide fields and are of such an elementary character that the average student would enjoy their study much more than the proof that two right angles are equal or that one side of a triangle is less than the sum of the other two. Moreover, both vector analysis and analytic geometry furnish simpler and more direct proofs of many theorems than the ordinary methods of elementary geometry and it seems poor policy to teach the poorer methods first.

The increasing use of graphic methods both in algebra and in the other sciences calls for a much earlier study of the elements of analytic geometry, and the enormous progress of physics calls for an early

acquaintance with such a strong tool as vector analysis. Moreover, a vector has so many physical applications that the line representing it becomes full of meaning to the student, and geometric constructions thus admit of interpretations which escape the notice of the student whose geometrical training has proceeded along the old lines.

The plea for an early introduction of the methods of analytic geometry has historical support since the 'Tractatus de latitudinibus formarum' of Oresme was popular during the period of the early development of European universities when very little of Euclid's 'Elements' were taught and the mental advancement of the students was low. The graphic representation of a function upon which so much stress has been laid in recent years was relatively farther advanced in these early days than it is at the present time. The thought of direct usefulness is again assuming a more dominating influence in early mathematical instruction. We are laying more stress upon the student's ability to use a theorem intelligently than upon his giving a faultless demonstration. In fact, a prominent Harvard professor is said to have told his students that the demonstration of a theorem is no evidence that it is understood, but the intelligent use of the theorem constitutes such evidence.

A fundamental aim in early education is to give the student a clear comprehension of the world in which he lives and to furnish him with the necessary knowledge to make a wise use of his faculties. In view of the fact that the sciences and their applications are continually playing a more prominent rôle in the civilized world and that international relations are becoming more and more important, it becomes necessary to readjust the machinery of education from time to time. Many of the necessary changes should be regarded as steps towards a proper readjustment rather than as fundamental progress. In view of the great conservatism in mathematics the readjustment along this line is apt to be slow and to require unusual perseverance.

When such strong men as Klein, of Germany, Forsyth and Sir Oliver Lodge, of England, Moore and Fiske, of America, take active part in reform movements they are certain to be effective. The discussions in Germany in recent years have been so active that Gutzmer describes them as stormy at times.[2] In France the discussions have received less attention, but there has been a decided movement towards graphic methods and especially towards the early use of the differential and integral calculus. In England Professor John Perry, of the Royal College of Science in London, has probably done the most radical and effective work, so that the reform movement is sometimes known as the 'Perry movement.'

While these tendencies in elementary mathematics have some influence on mathematical instruction in the universities, yet they do not affect this work nearly so much as the elective system in secondary education. In view of the diversity of the courses pursued by students before entering the universities, the departments where the work has to proceed step by step, as in mathematics, are compelled either to make provision for more elementary courses or to exclude a large number of students. This difficulty exists not only in our institutions but also abroad, and Klein, for instance, urges that the universities should meet the difficulty by offering a greater variety of courses. He discourages the efforts on the part of friends of the real gymnasium who have tried to abolish some elementary courses in languages at the universities with a view to securing a more general

[2] Jahresbericht der Deutschen Mathematiker Vereinigung, Vol. 13, p. 517.

recognition of the equality of their courses to those of the older gymnasium.

A fundamental tendency in the early university instruction is towards a closer coordination with applications. In a less marked degree the coordination of the various mathematical subjects has been considered. The latter seems wise, as reforms should begin at home. Before considering the closer union of mathematics and physics, for instance, it might be well to consider whether the water-tight compartments of the various mathematical subjects are not doing more mischief than those between the various departments. While mathematics should be taught with a view to helpfulness to other departments, yet its first duty is to help itself and to secure its own harmonious development. A starveling can not render strong service to others.

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SCIENTIFIC BOOKS.

California Mammals. By Frank Stephens. Illustrated by W. J. Fenn from studies in the field. Published by the West Coast Publishing Co., San Diego, California, 1906. 8vo, pp. 352, frontispiece, 6 half-tone plates, 40 illustrations in the text, and a faunal map.

'California Mammals,' by Mr. Stephens, is noteworthy as being the first recent local 'handbook' of the mammals of any part of North America, and fortunately sets a fairly good standard for the many similar much-needed local manuals of our mammals that we hope may speedily follow. The scope of the work is "California and that part of the Pacific Ocean properly belonging to California. All the mammals described are known to have been found within the state or within sight of its shores." The number of species and subspecies treated is 276—a surprisingly large number, yet readily explained by the great latitudinal extent of the state, and its extremely diversified character, ranging from the subtropical desert areas of the southeastern part to the subarctic snow-covered summits of the Sierra Nevada.

Although diagnoses of the higher groups, from class to genus, are given, the work is written as far as practicable in non-technical phraseology, but for the convenience of such readers as may not be familiar with some of the terms necessarily employed, a three-page glossary is supplied. Mr. Stephens is well equipped for his work, having had a long field experience as a natural history collector in California, and is thus able to give the ranges of the species and subspecies, particularly of the southern two-thirds of the state, largely from his own personal knowledge. The descriptions of the forms are brief, but for the most part give all there is to say. These are followed by a statement of the type locality and range, and by a few lines to several pages of original biographical matter, according to the circumstances of the case. There is no synonymy, nor any bibliographical references, but the life histories are an important contribution. The illustrations are not numerous, and relate wholly to external features. Good figures of skulls of a considerable number of genera would have been a valuable addition; an extended bibliography was obviously beyond the scope of the work, but a list of titles of the principal papers relating to California mammals would have been useful. The book had to have its limitations, and for a work so well done as is this, and containing so much that is convenient and valuable, it is perhaps hardly fair to make suggestions that the author, perhaps, considered and found impracticable of execution. There is only one thing to say in the matter of serious criticism, and that is that the work is worthy of better typographical execution. The text, as to matter and style, is excellent, but the proofreading is unfortunately defective.

The work is intended for 'beginners' and not for experts, yet it is doubtless equally welcome to both, and for the first class it has been put together with excellent judgment. For many of the subspecies, especially in certain groups, it is almost impossible to give